

Hydroclimatic Change on the Salt and Verde River Watersheds, Arizona

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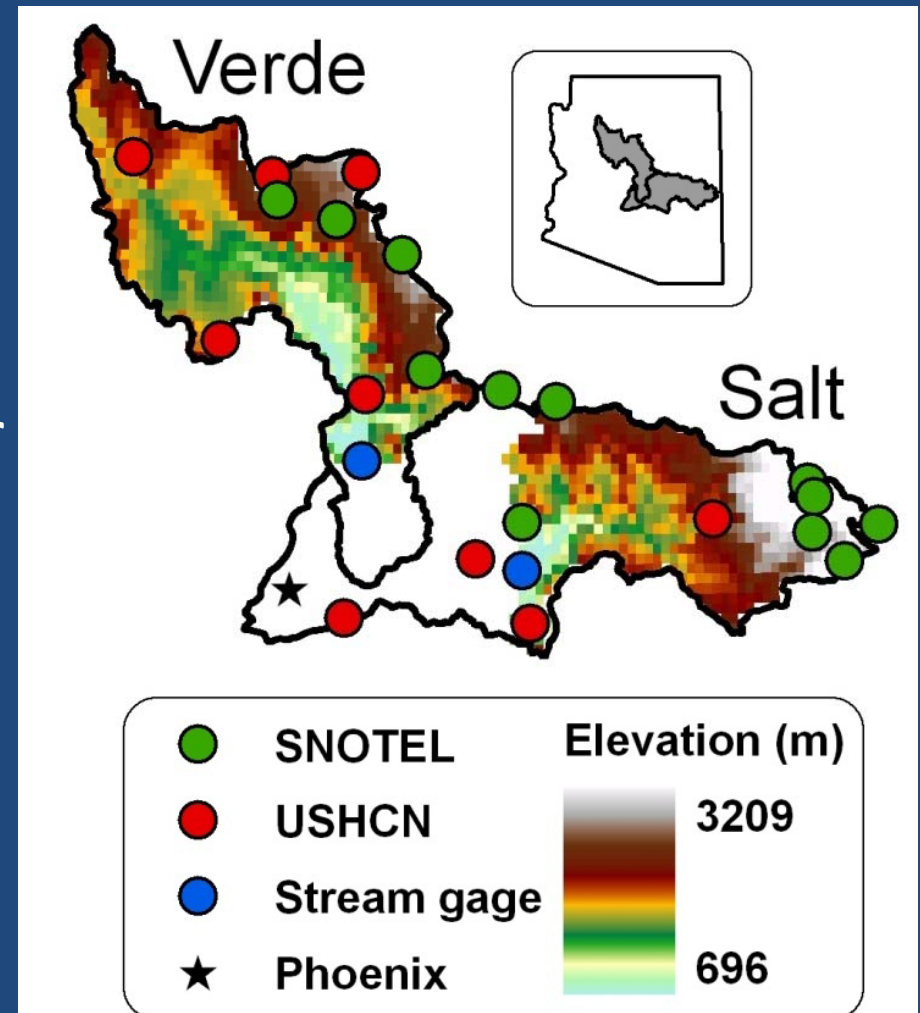


Outline

- Watershed description
- Water resources background
- Temperature and precipitation
- PDO
- Snow
- Streamflow
- Hydrologic model
- Evaporation and soil moisture

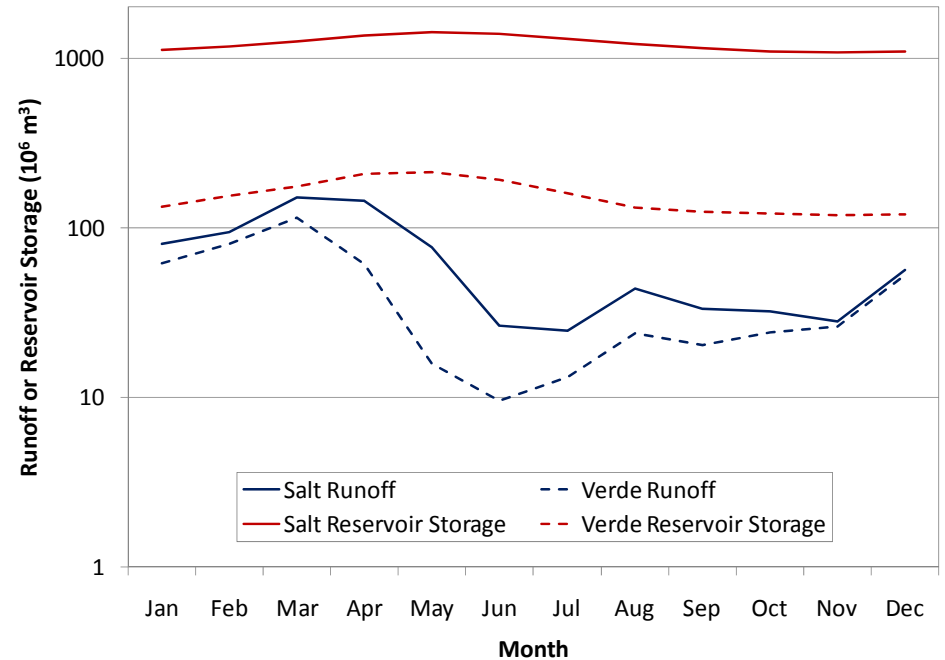
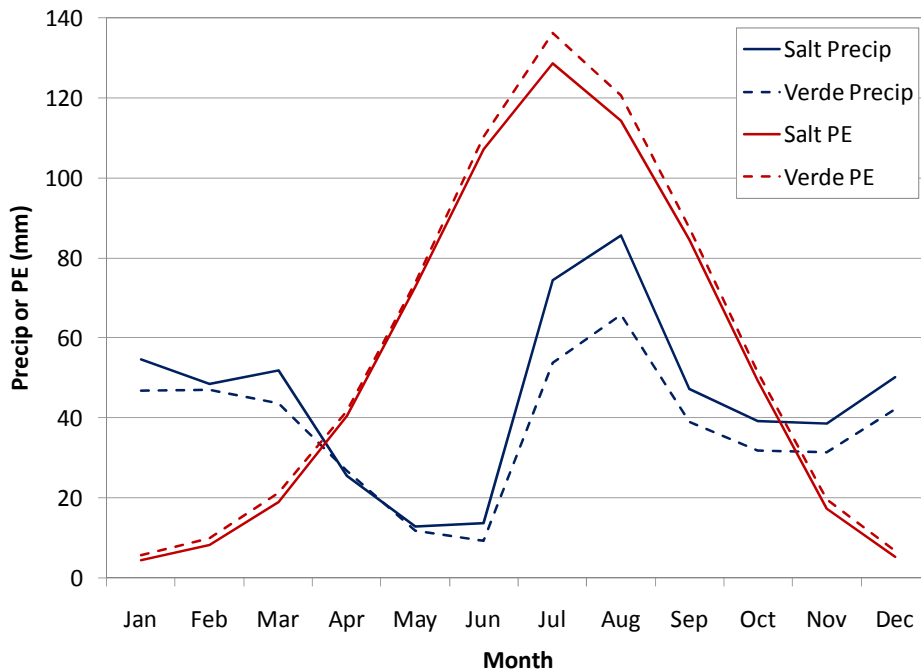
Salt and Verde River Watersheds

- 33,800 km²
- 6 dams/reservoirs
 - 2.3 million ac-ft capacity
 - 1 million ac-ft delivered/yr
 - 40% central AZ water
 - 4 million residents
 - 2040: 8 million residents
- Salt: 88% of capacity

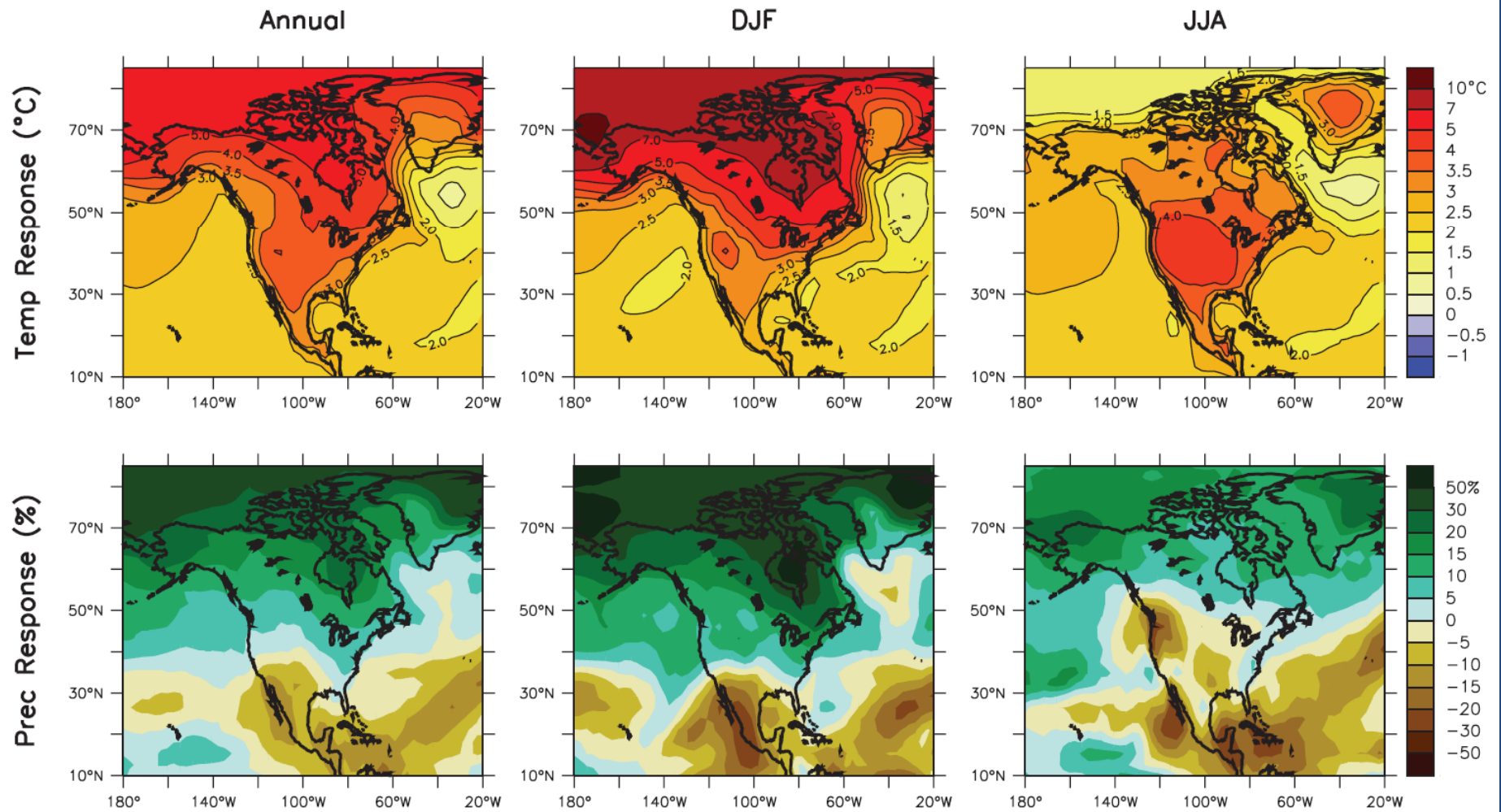


Average Hydroclimate

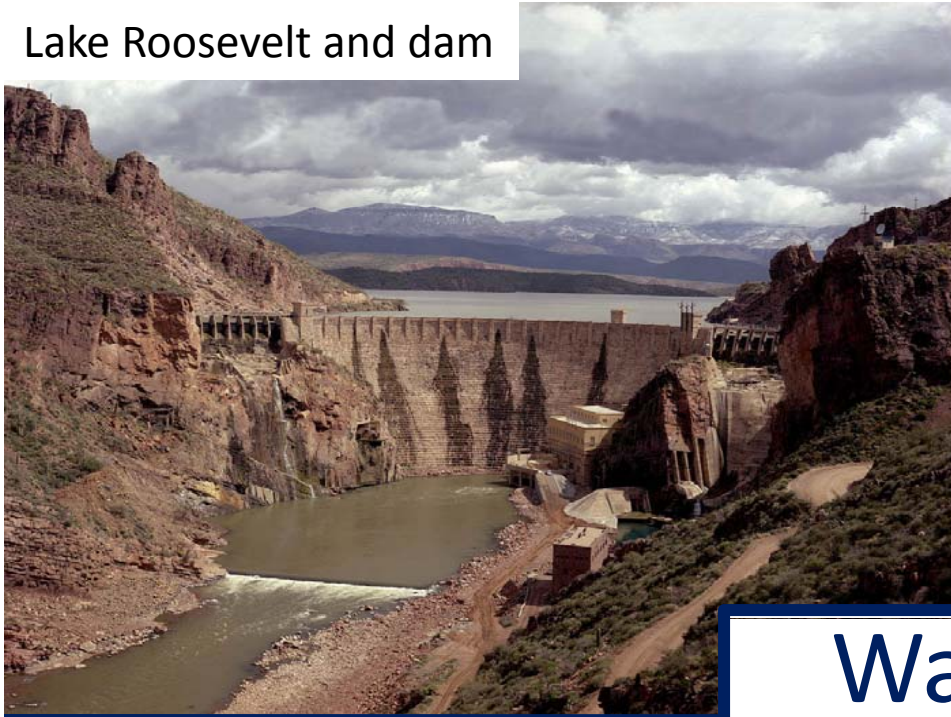
	Precipitation	Potential Evaporation	Runoff
January -March	30%	5%	46%
July - September	37%	58%	12%



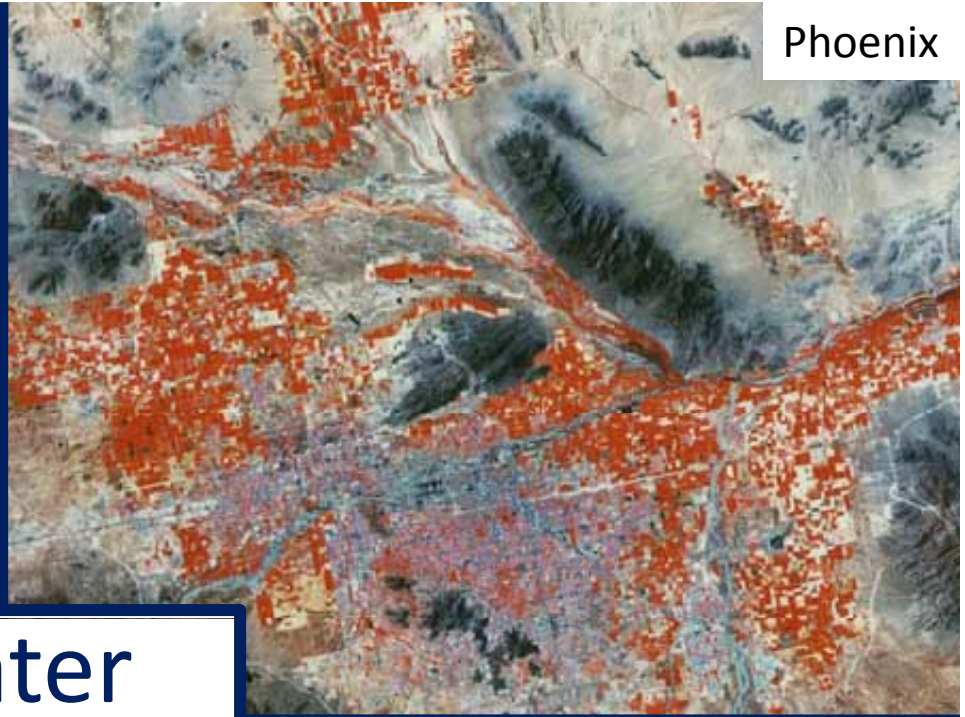
IPCC Projected Change 2080-2099



Lake Roosevelt and dam



Phoenix

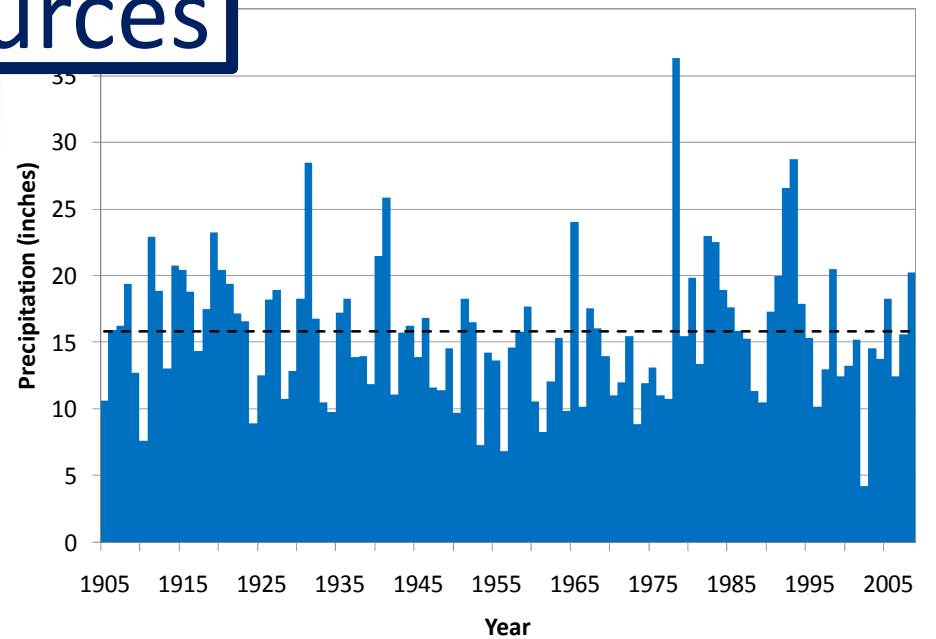


Water Resources

Lake Roosevelt, July 2002

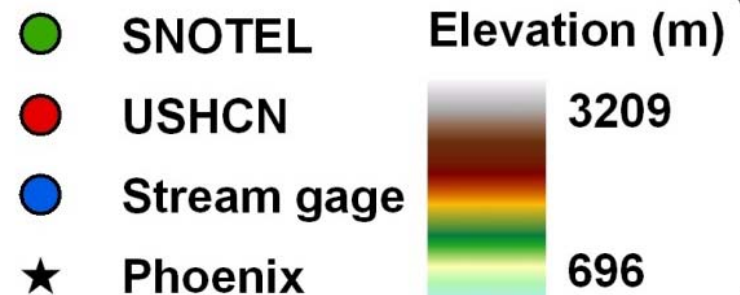
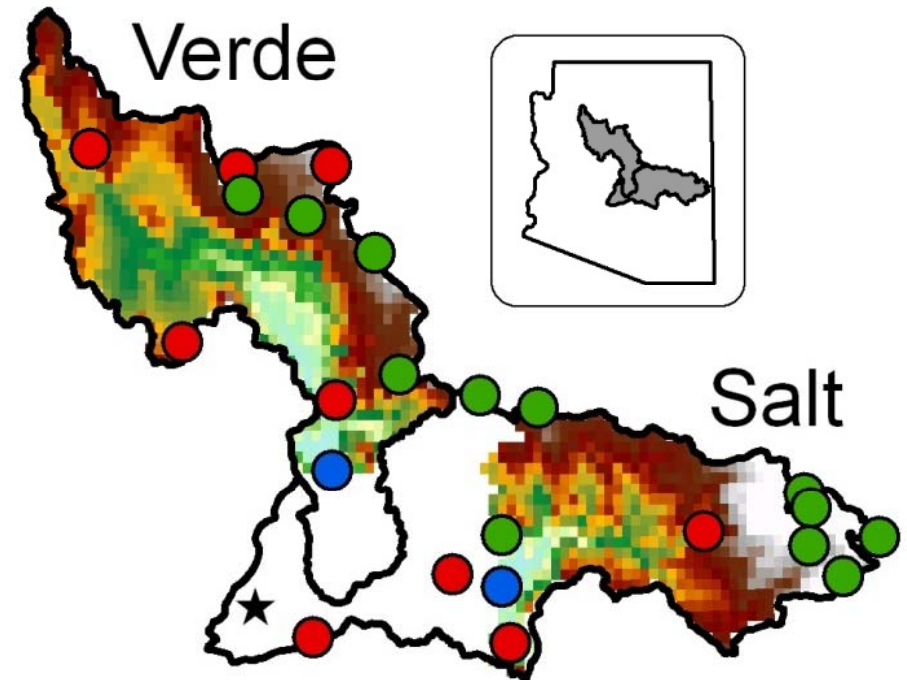


Roosevelt Dam Precipitation



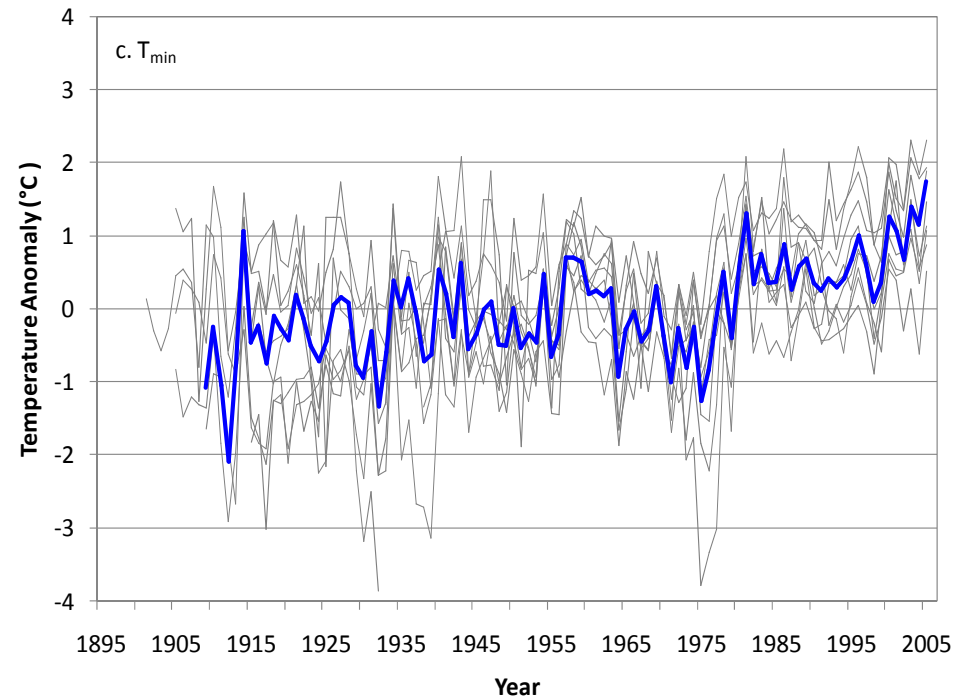
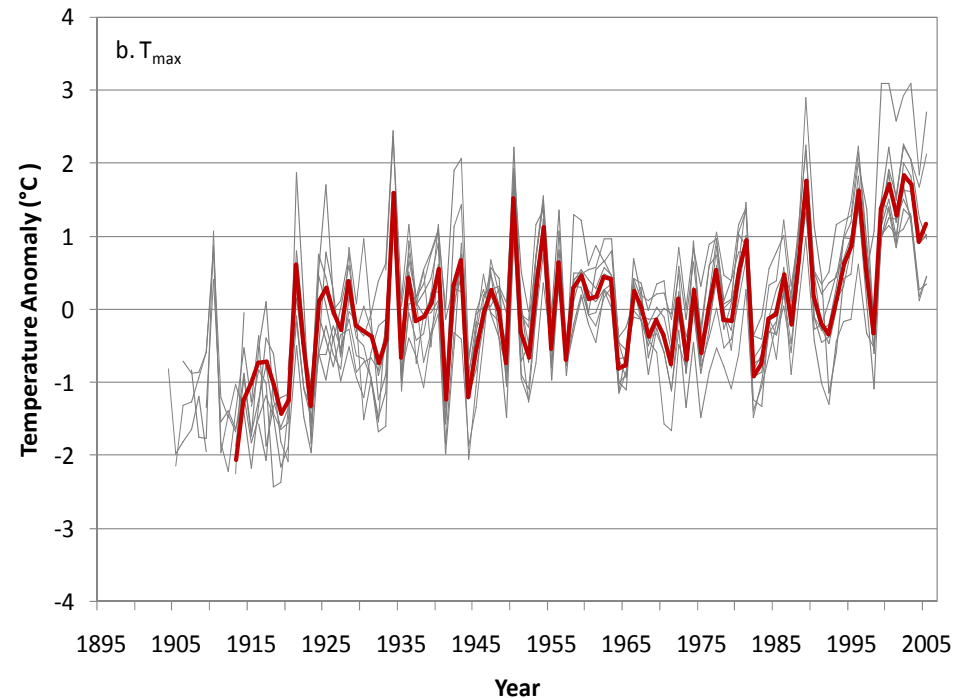
Temperature and Precipitation

- 9 USHCN stations
- 4 Salt, 5 Verde
- 376-2239 m
- Monthly, seasonal, annual data
- Record start: 1867-1916



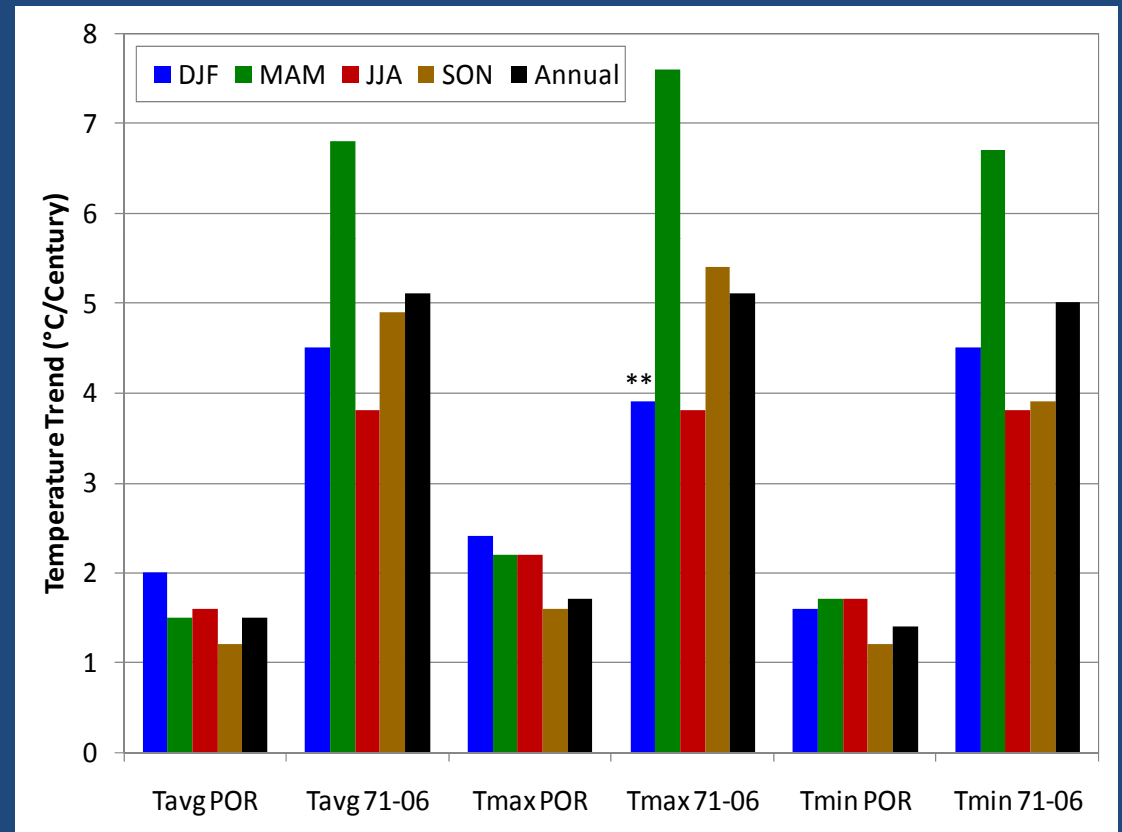
Annual Temperature

- $1.5^{\circ}\text{C}/\text{century}$ T_{avg}
- $5.1^{\circ}\text{C}/\text{century}$ T_{avg} since 1971
- More minimum variation



Seasonal Temperature

- Greater recent trends
- POR
 - Winter greatest
 - Fall least
- 71-06
 - Spring greatest
 - Summer least

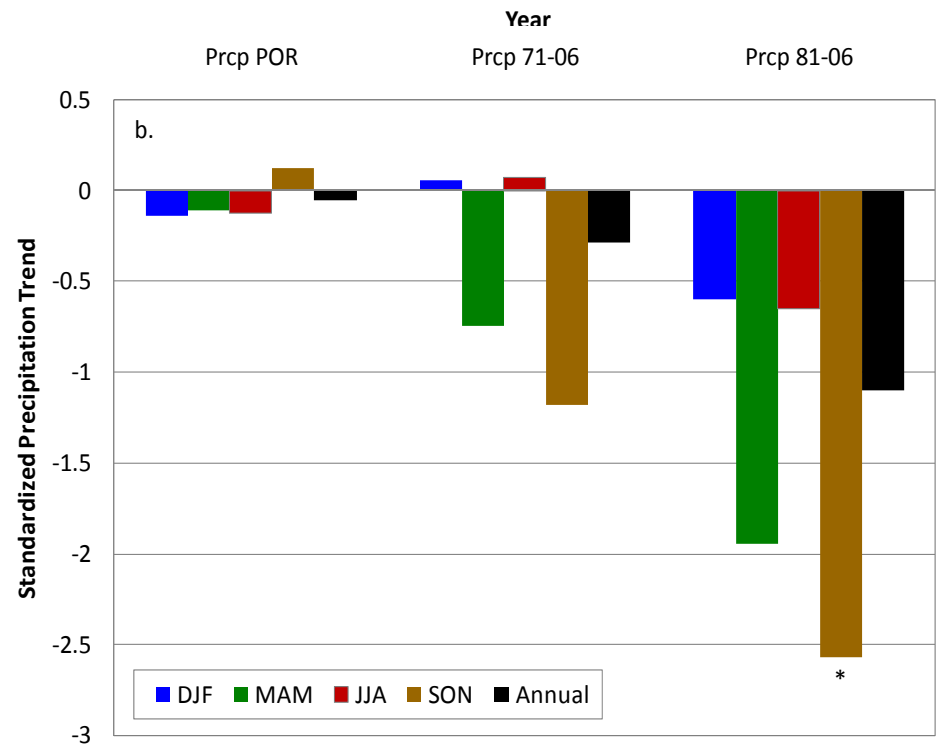
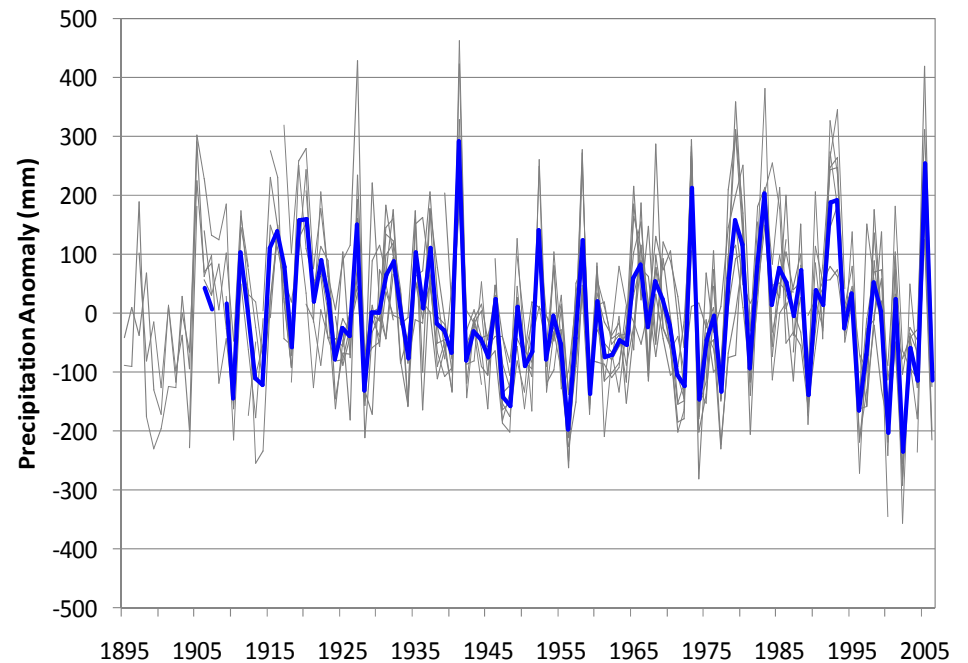


** 90% confidence, rest 95% confidence

Precipitation

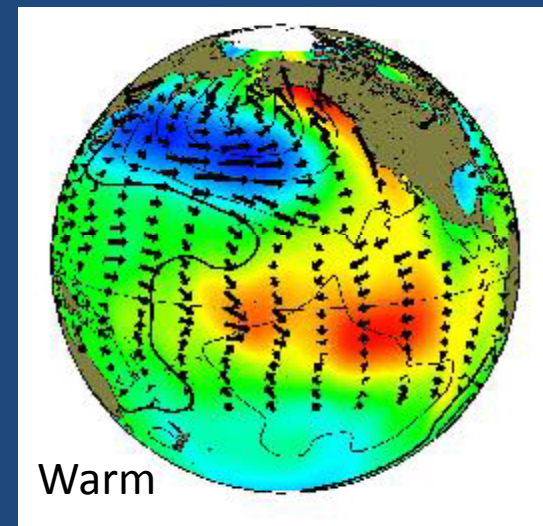
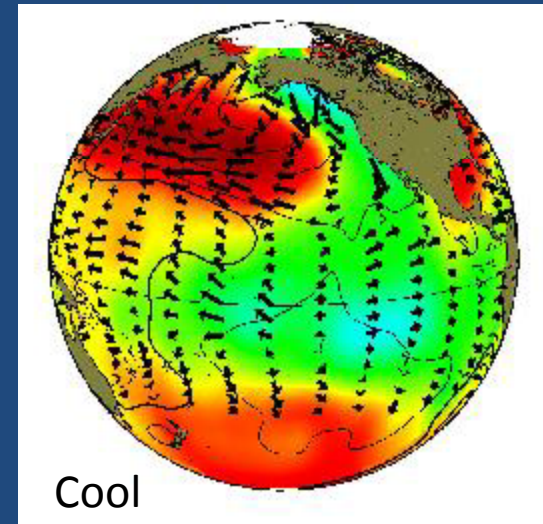
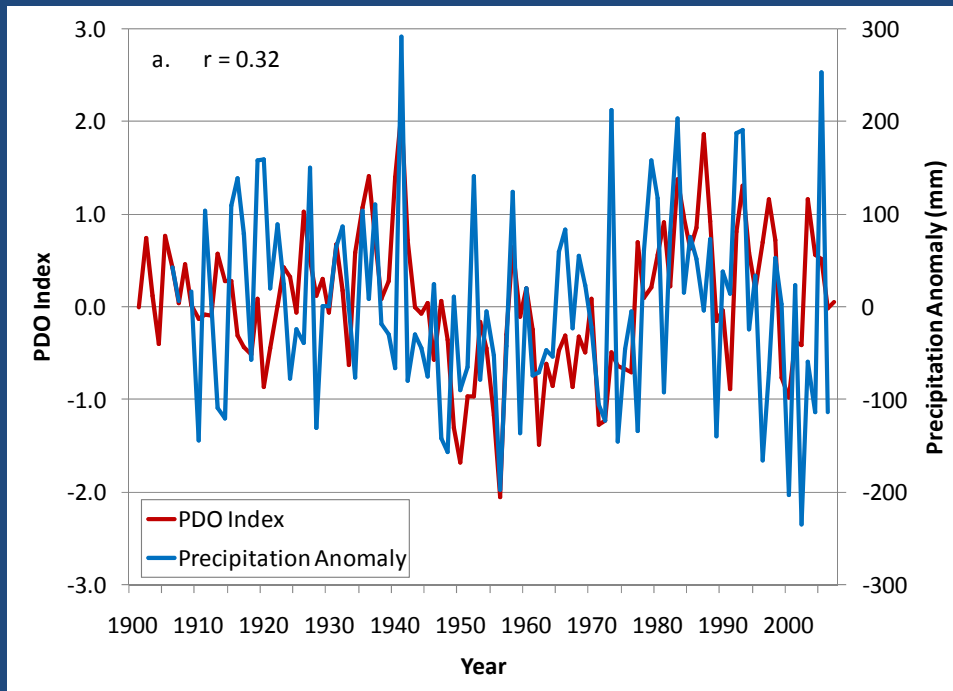
- Annual trend not significant
- Only one seasonal trend significant
- Spring and Fall greatest trends
- Greater recent trends

* 95% confidence



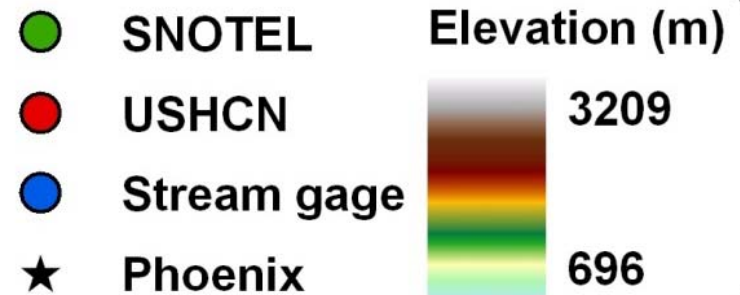
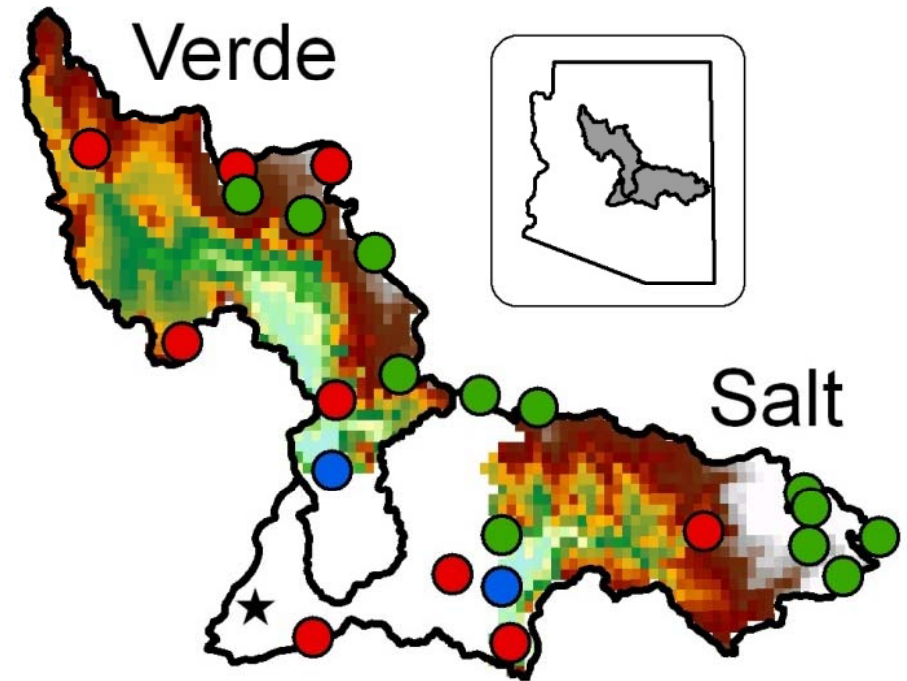
PDO and Precipitation

- Similar SST as El Niño
- 20-30 year cycle
- Correlates with precip.



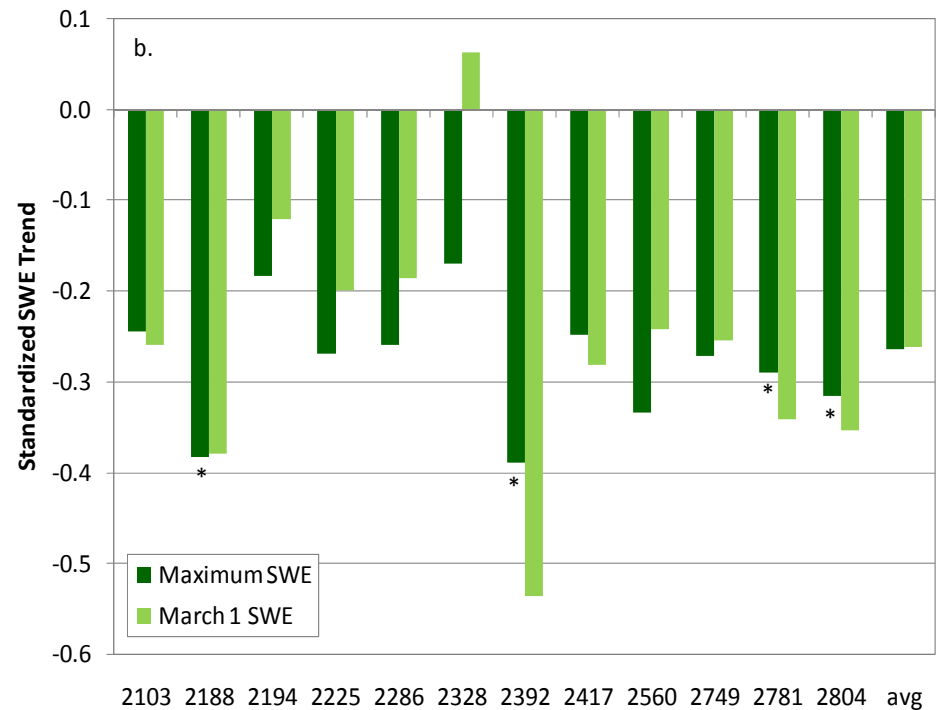
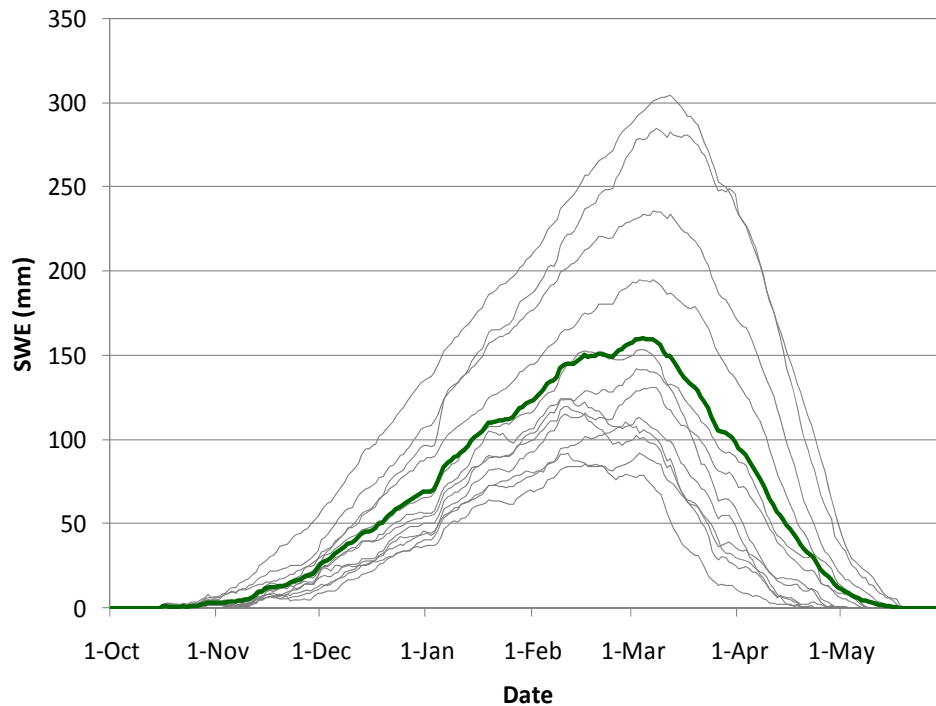
Snow

- 12 SNOw TElemetry
 - 2103-2804 m
 - Start in 1983



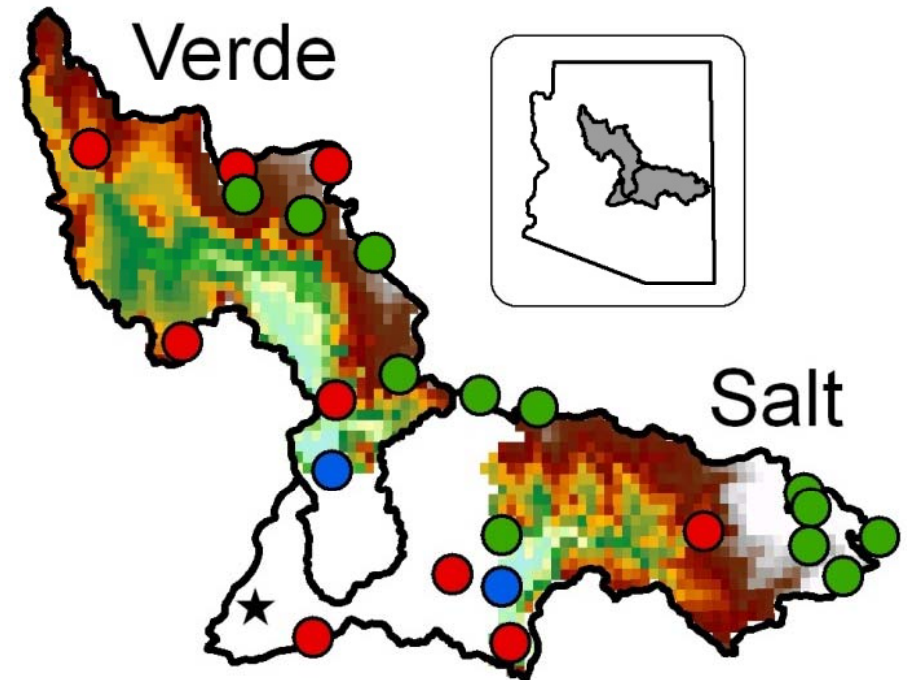
Snow

- Most trends not significant
- Decrease in SWE



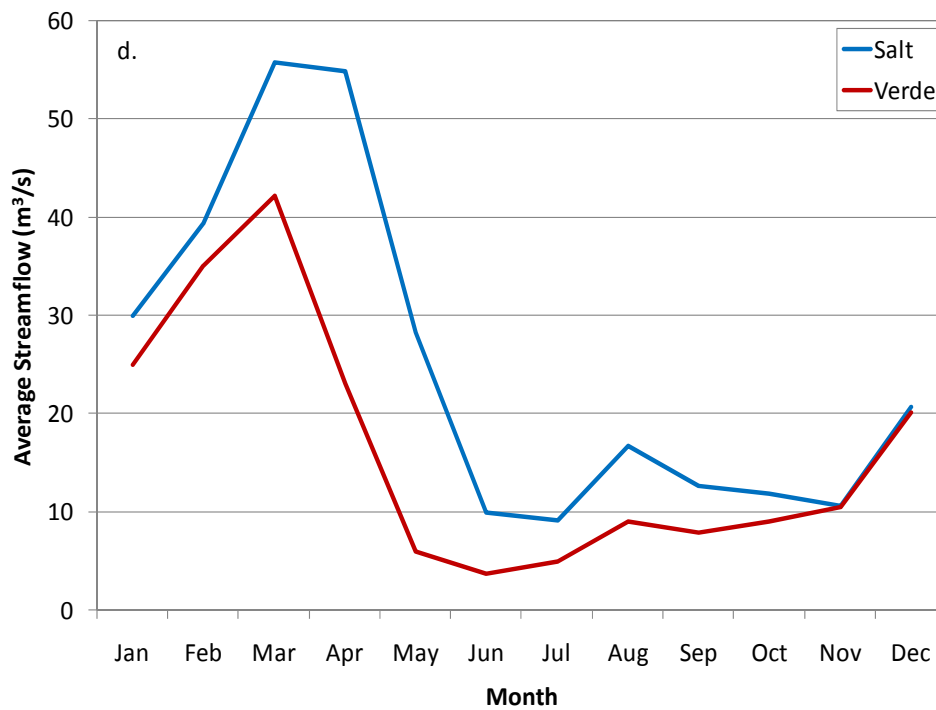
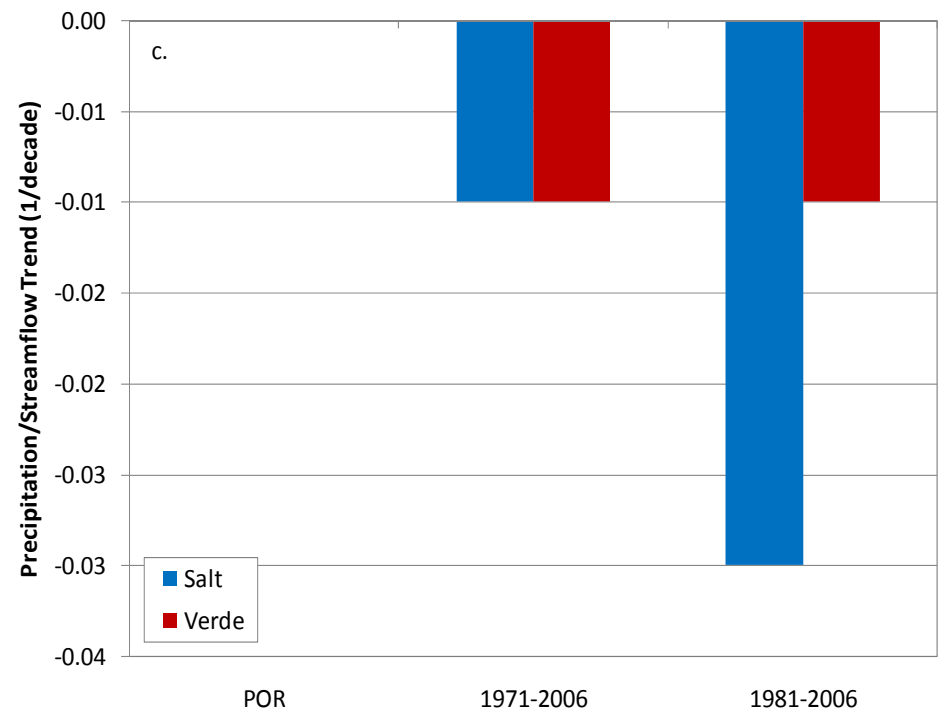
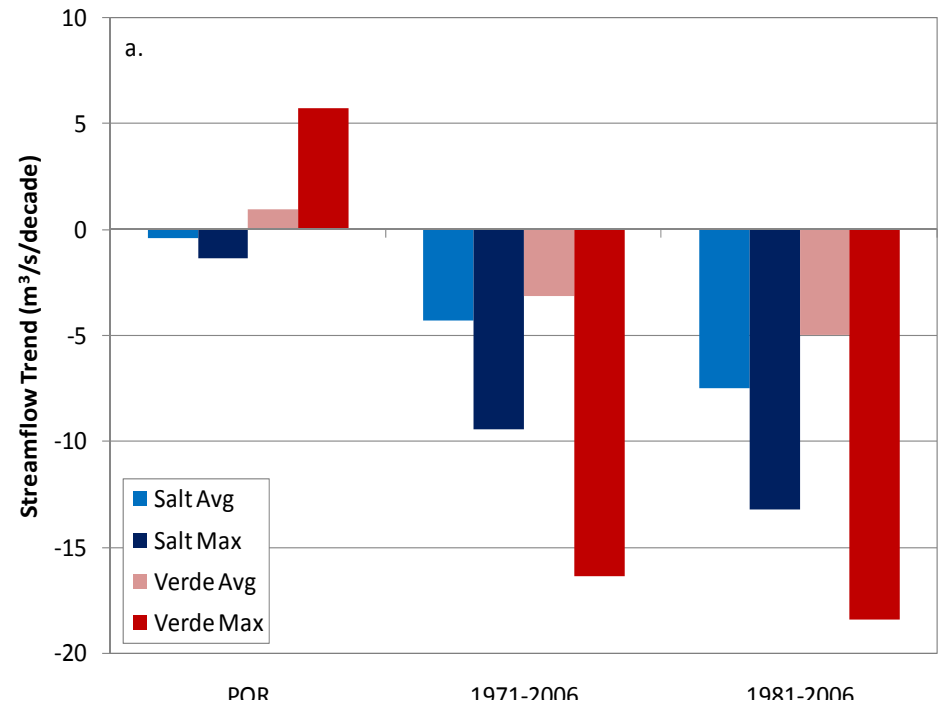
Streamflow

- 2 USGS gages
 - Salt: 1914
 - Verde: 1946
- Entry points to reservoir system
- Annual inflow
 - Salt: 55%
 - Verde: 35%
 - Tonto: 10%
- Drainage area
 - Salt: 11,152 km²
 - Verde: 14,229 km²

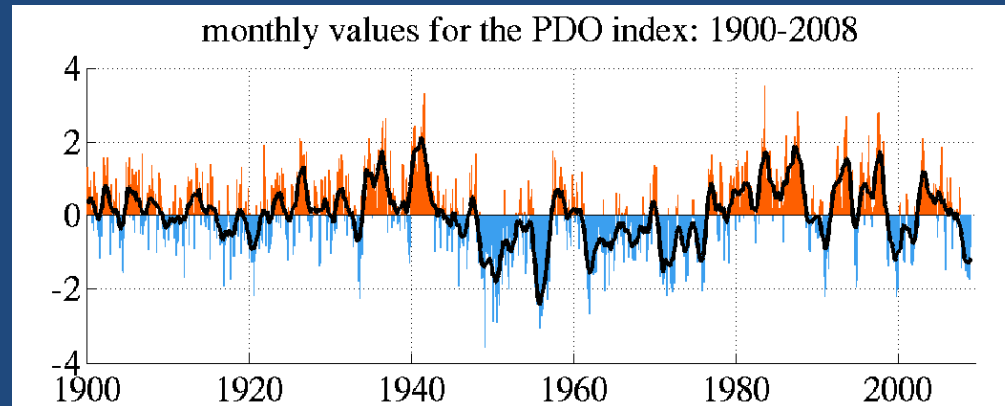


Streamflow

- Trends not significant



Trends for PDO Periods



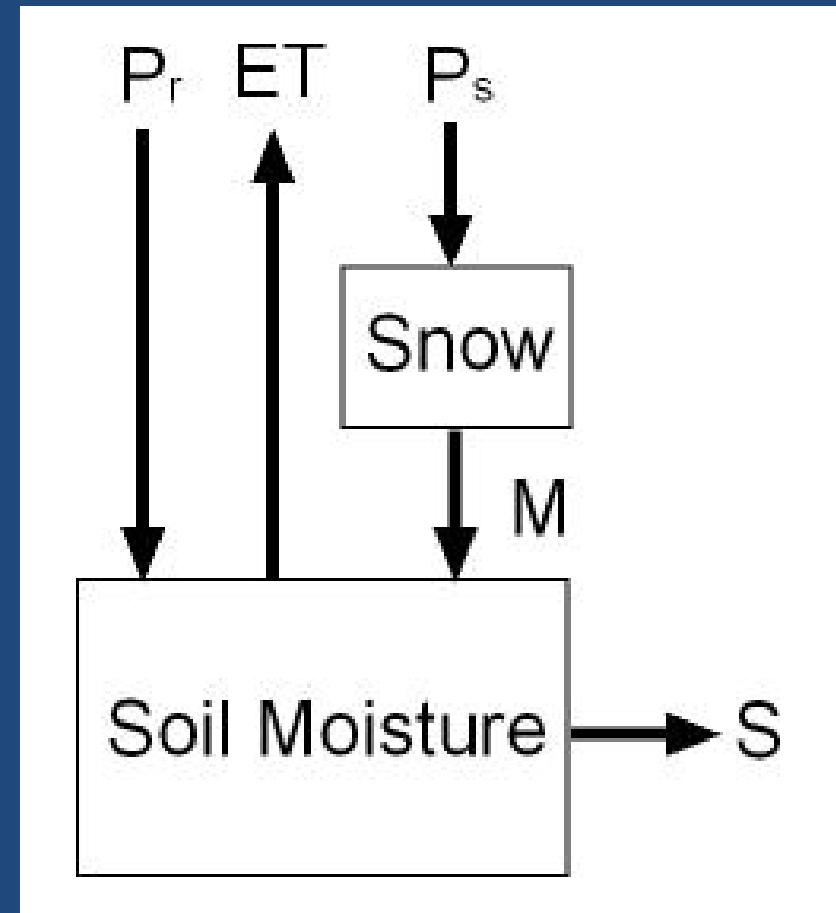
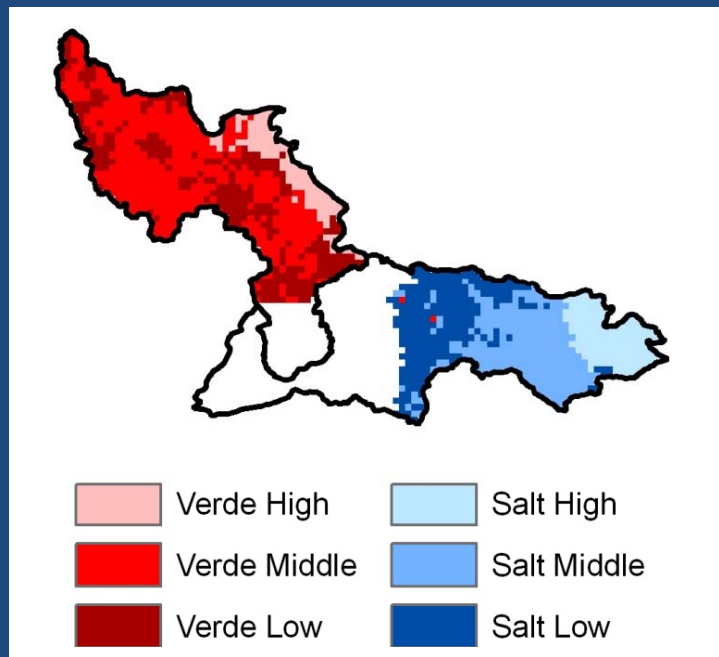
	1923-1942 warm	1977-2006 warm
Precip (mm/decade)	31.33	-40.77
Snowfall (mm/decade)	352.69	*-311.28
Salt Q_{avg} (m ³ /s/decade)	5.58	*-8.99
Verde Q_{avg} (m ³ /s/decade)	NA	*-6.92
Salt Q_{max} (m ³ /s/decade)	16.11	-30.21
Verde Q_{max} (m ³ /s/decade)	NA	** -41.64
Salt Q ratio (1/decade)	0.01	** -0.03
Verde Q ratio (1/decade)	NA	* -0.02

* 95% conf.

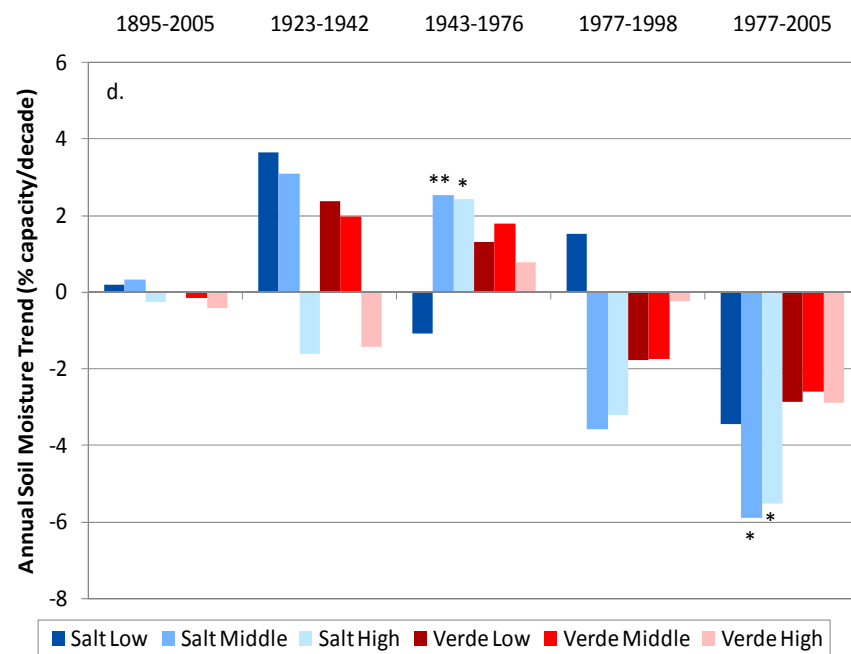
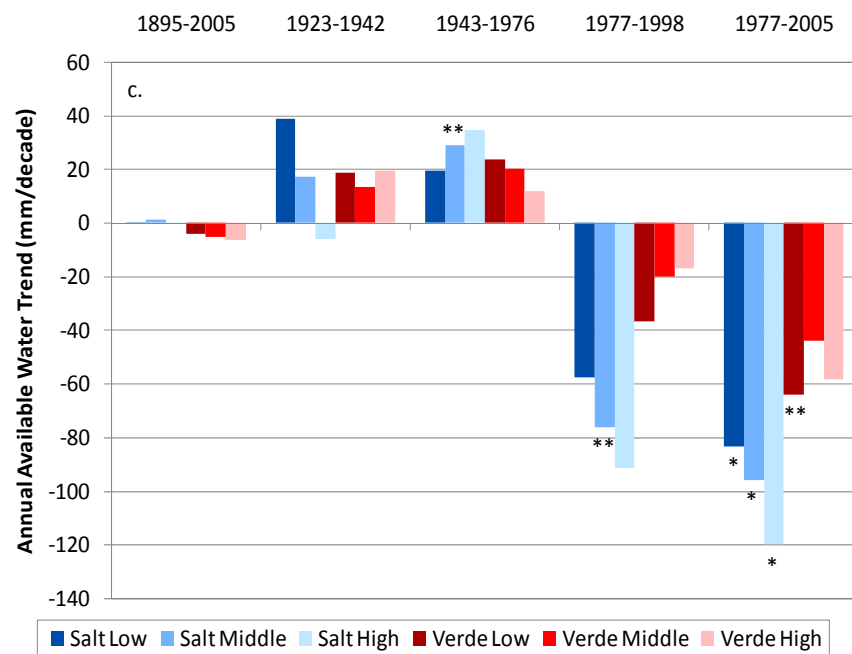
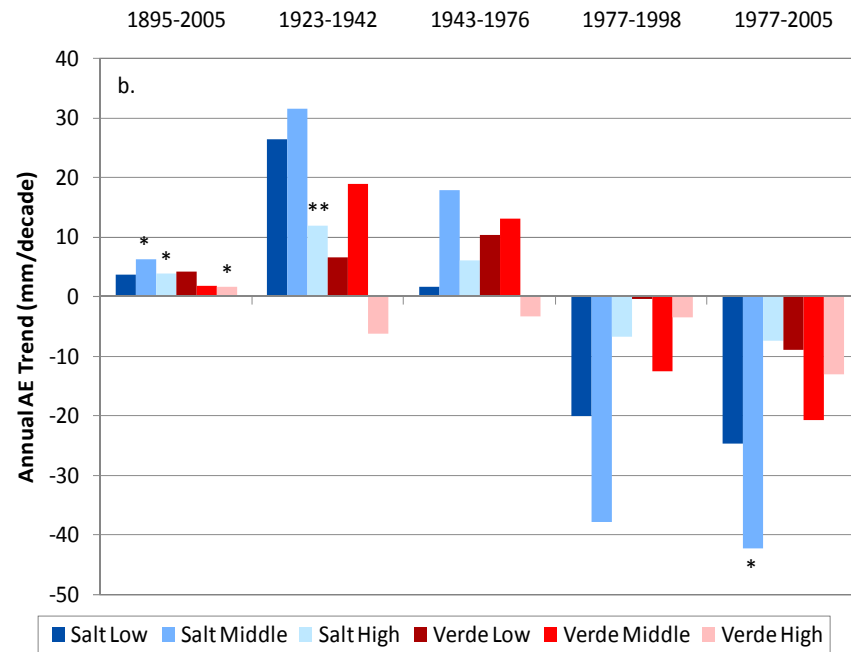
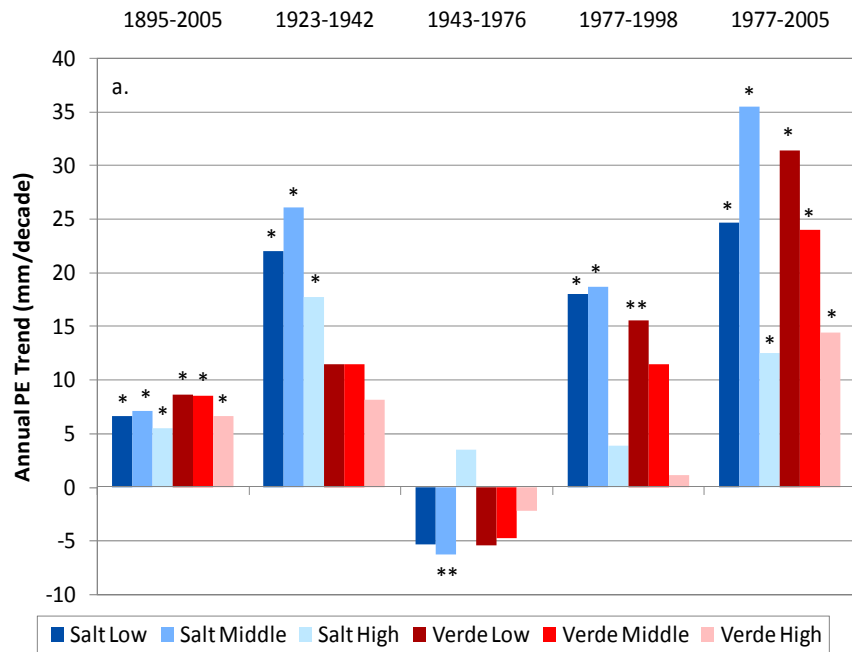
** 90% conf.

Hydrologic Model

- 1485 grid cells
- Monthly PRISM input
- PCA of soil moisture



$$\Delta SM (mm) = P_r + M - ET - S$$



Questions?

Horseshoe "Lake" and dam, July 2002



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